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FM 6-3

DEPARTMENT OF THE ARMY FIELD MANUAL

Superseding FM 6-3-1 (June 1958)

GUN DIRECTION COMPUTER M18

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HEADQUARTERS, DEPARTMENT OF THE ARMY

MARCH 1963

AGO 8155A

FIELD MANUAL
No. 3-6

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *14 March 1963*

GUN DIRECTION COMPUTER M18

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CHAPTER 1

GENERAL

1. Purpose

This manual is a guide to assist commanders in training artillery personnel in the operation and maintenance of the gun direction computer M18.

2. Scope

a. This manual covers the operation of the gun direction computer M18 in the nonprogram associated and general program functions; emplacement and march order; organization and employment; maintenance; and destruction.

b. The material presented herein is applicable, without modification, to both nuclear and nonnuclear warfare.

c. Related publications are listed in appendix.

d. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded to the Commandant, U.S. Army Artillery and Missile School, Fort Sill, Okla.

3. Equipment

a. The gun direction computer M18 (fig. 1) contains a magnetic memory assembly, two air blowers, power supply assemblies, computer electronic circuitry, and a removable control section which contains the control panel, mechanical tape reader, keyboard, readout (Nixie) panel, and indicators.

b. Associated equipment consists of a gun direction computer table, a cable and reel assembly, and a 120/208-volt, 400-cycle, three-phase, four-wire generator.

c. Auxiliary equipment consists of the signal data reproducer AN/GSQ–64 (MLU) and the computer logic unit test set AN/GSM–70 (FALT).

d. The gun direction computer M18 and associated equipment is discussed in detail in TM 9–1220–221–10/1 and TM 5–6115–211–10 to include nomenclature, technical characteristics, and operation of the equipment.

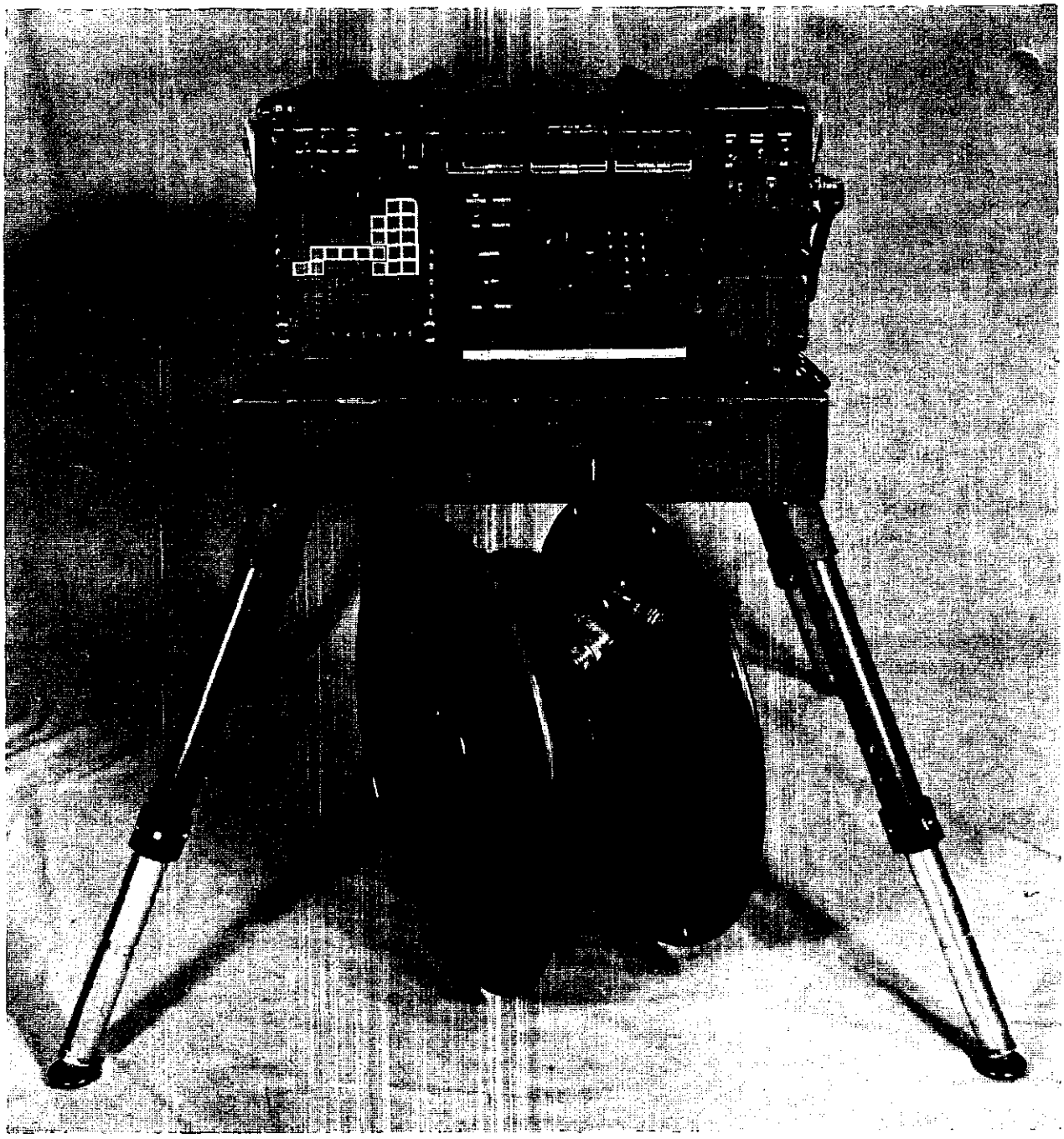

Figure 1. Gun direction computer M18.

CHAPTER 2

ORGANIZATION AND OPERATION

Section I. ORGANIZATION

4. General

The gun direction computer M18 is authorized for issue to the fire direction or operation section of each headquarters and headquarters battery of all divisional direct and general support field artillery battalions; each divisional battery which has nuclear capability; each separate field artillery cannon battalion; each separate field artillery missile battalion, Little John, Honest John, and Lacrosse; the survey information center (SIC) of each field artillery target acquisition battalion; and the headquarters and headquarters battery of each division artillery.

5. Personnel

The assigned personnel operate the computer as the primary computational means in the battalion and battery fire direction centers, and survey information centers for all applications for which the computer was developed. Regardless of the application, the minimum number of personnel required to operate and maintain the computer in sustained operations is four—two computer operators and two generator operators.

6. General Duties of Personnel

a. Computer Operator. The computer operator (fire direction computer) is a team member of the fire direction center, survey information center, or other computation agency and is responsible for—

(1) Employment, march order, operation, first-echelon maintenance, and inspection of the computer and associated equipment, such as the cables and program tapes.
(2) Insuring that the generators assigned for the operation of the computer are operated and maintained properly.
(3) Reporting discrepancies in computer maintenance to the chief of section.
(4) Transmitting and/or recording data in accordance with the SOP (standing operating procedure) for the particular section in which he is operating.
(5) Insuring that proper caution is exercised in handling the computer and associated equipment.

b. Generator Operator. The duties of the generator operator are normally performed as additional duties by another member of the section which utilizes the computer. In addition to his regular duties, the person assigned the duties of generator operator is responsible for—

(1) Insuring the proper emplacement of the generator.
(2) Starting, shutting down, and monitoring the operation of the generator on a standby basis.
(3) Insuring that the generator is providing the proper current outputs.
(4) Performing first-echelon maintenance on the generator and reporting discrepancies in generator maintenance to the chief of section.
(5) Maintaining prescribed records on generator operation.

Section II. PREPARE FOR ACTION AND MARCH ORDER

7. General

The gun direction computer M18 requires a minimum of four men to prepare the equipment for operation. Caution must be exercised to prevent damage to the equipment and injury to personnel.

8. Preparing for Operation

a. Unless semipermanently mounted in a vehicle, the gun direction computer M18 is prepared for operation in the following sequence:

(1) Unfold the legs of the field table after releasing the screw-lock fasteners.
(2) Extend each leg to maximum length and secure it in position by tightening the leg locking ring. The height of the table may be adjusted as required by the operator.
(3) Using two men, place the computer on the table. Fasten the four latches on the table over the four hooks on the computer case.
(4) Open the pressure release valve by depressing the valve core.
(5) Remove the front and rear covers.
(6) After removing the cap, connect cable P11 from the table to receptacle J11 on the computer.
(7) Connect the end of the power cable to receptacle J1 on the field table.
(8) Start the generator.
(9) Check the air intake, located on the forward end of the bottom panel of the computer for obstructions.
(10) Check the fire control system record book to determine the program in the memory.
(11) Apply primary power to the computer by moving the power switch on the control panel to the PWR ON position. The computer is ready for operation when the PWR READY indicator lights.

b. If the computer is semipermanently mounted in a vehicle, the procedures prescribed in *a*(4) through (11) above apply.

9. March Order

a. The gun direction computer, if not semipermanently mounted in a vehicle, is prepared for traveling in the following sequence:

(1) Move the power switch (fig. 2) to the PWR OFF position.
(2) Stop the generator, disconnect the power cable, and replace the power cable on the cable and reel assembly.
(3) Disconnect all cables from the gun direction computer. Replace the front and rear covers.
(4) Remove the computer from the field table.
(5) Secure the plug of the computer power cable to the dummy receptacle under the field table.
(6) Turn the field table on its side with the carrying handle up.
(7) Release the telescoping portion of each leg by turning the leg locking ring counterclockwise, and retract and fold the legs.
(8) Place the equipment in the transport vehicle for movement.

b. To march order a computer semipermanently in a vehicle, the procedures in *a*(1) through (3) above apply.

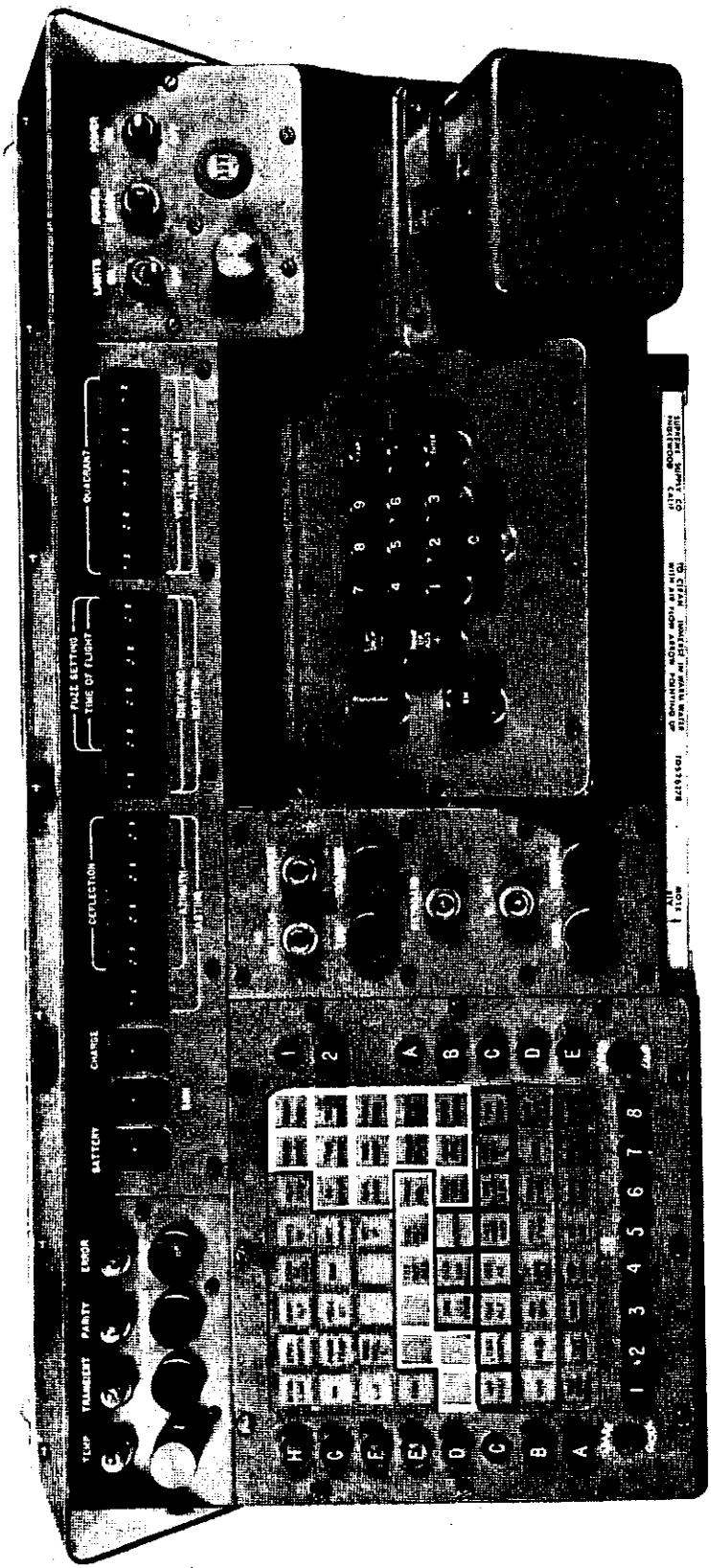

Figure 2. Computer control panel.

Section III. PREOPERATION

10. General

The computer should be checked by the operator to insure that the computer is ready for operation. The computer should also be checked when it is first installed or whenever the operator has reason to believe the equipment is not operating properly. If the proper program is not in the computer memory, or if the program must be changed, the radio mechanic at battalion may procure the signal data reproducer AN/GSG–64 (MLU) from the appropriate headquarters battery, (par. 22) to accomplish the program change.

11. Bit-Sum Test

a. General. The bit-sum test is designed to insure that the program is properly entered into the computer. It is performed by the operator at his discretion. The test adds all the numbers stored in the computer memory and compares the sum with a previously stored constant. If the program is properly stored, the computer displays a series of zeroes in the Nixie tubes.

b. Procedure. The following procedures apply to the cannon program only.

(1) Depress the TEST button. The keyboard light should go on.

(2) To check permanent storage, depress the 1 key. A series of zeroes appear in the EASTING window and the left three NORTHING windows if the test is successful.

(3) To check working storage, repeat (1) above, and depress the 2 key. The number 136 appears in the right three QUADRANT windows if the test is successful.

(4) If either of the tests in (2) and (3) above is unsuccessful, the PARITY or NO SOLUTION light will flicker and a number other than zeros or 136 will appear in the Nixie windows. Attempt the test again. Success on the second or third attempt indicates the program is entered correctly but there may be aging parts. The radio mechanic should be notified as soon as possible.

12. Marginal Test

a. General. The marginal test is built into the gun direction computer M18. It provides the operator with a means of performing a limited check of the computer's operation when intermittent malfunctioning is suspected or known.

b. Procedures. The marginal TEST switch has five positions for testing the computer under various combinations of fluctuating voltages along with an introduced timing clock jitter.

(1) The No. 1 position of the switch causes the generation of a steady malfunction by causing the PARITY or ERROR light to blink when a problem is computed or when the program test is activated. Any of the five positions causes the POWER ON indicator to blink.

(2) The other test positions, Nos. 2 through 5, may produce the steady malfunction as in (1) above if the first test position fails to generate the error. If the marginal test produces the error, notify the radio mechanic for further checkout of the computer by utilizing the logic tester, FALT.

(3) In normal operation the marginal test switch is in the OFF position. The POWER ON indicator light will be steady and nonblinking.

Section IV. NORMAL OPERATION

13. General

The procedures listed in this section are necessary for accomplishing the artillery problem. Variations are made in the input selection matrix to provide proper input legends for the different applications, i.e., cannon, rocket, guided missile, survey, meteorology, etc.

14. Function of Controls and Indicators

The function of each control and indicator on the computer control panel (fig. 2) is described as follows:

a. POWER ON-OFF. This is a momentary contact center return switch which, in the ON position, energizes the power supply, blowers,

and memory. In the OFF position the computer is deenergized.

b. POWER READY. This indicator lights approximately 20 seconds after the computer is energized. The indicator blinks when the computer is in the marginal test mode.

c. LIGHTS ON-OFF. This switch lights the computer lamps for night operation.

d. TIME METER. The time meter records total time the computer has been in operation.

e. TEMP. This indicator is lighted when the internal operating temperature is correct. The light blinks when the operating temperature is not correct.

f. TRANSIENT. This indicator is lighted when the line voltage is correct. The light blinks when supply voltages approach the tolerances of 100 to 140 volts.

g. PARITY. This indicator blinks when incorrect information is transferred from an input device to the memory, or from the memory to an output device.

h. ERROR. This indicator blinks when an internal overflow has occurred or a verification process fails to give correct results.

i. SET UP. In the cannon program, only this switch, when depressed, associates information relative to weapon type with selected batteries. This switch is controlled by an interlock position (F–5) on the input selection matrix. All constants pertaining to a given caliber are set to standard—muzzle velocity, projectile weight.

j. TEST. When this button is momentarily depressed, computation of a stored test problem begins and the COMPUTE indicator lights during the solution of the test problem. When the test problem is completed, the COMPUTE indicator light goes out.

k. RESET. This switch is momentarily depressed to clear an error which is indicated by a blinking PARITY, TRANSIENT, or ERROR indicator. The computations in process are cleared, the indicators cease blinking, and the operator must repeat the computation.

l. NO SOLUTION. This indicator blinks if parameters associated with the problem produce an out-of-range condition or if a required input parameter is omitted prior to going into compute.

m. COMPUTE. This indicator lights when computations are being made.

n. TRIG. This switch, when depressed, sets the computer into the proper program to compute trigonometric corrections to previously computed trajectory solution. It also allows the computer to perform computations necessary in certain survey problems.

o. COMPUTE. This switch, when depressed, places the computer in the proper mode to compute the trajectory solution for the ballistic problem.

p. KEYBOARD. This indicator lights when the computer requires information which must be entered through the keyboard.

q. IN/OUT. This indicator lights when information is being transferred to or from an input-output device. This indicator, as well as the keyboard indicator, must light to allow input through the keyboard.

r. SEND. This switch, when depressed, causes information to be transmitted to a second computer, battery display unit, or other output equipment.

s. RECEIVE. This switch, when depressed, causes the computer to receive information from another computer, or other input equipment.

t. Keyboard Assembly.

(1) *SM* (Sample Matrix). This key, when depressed, permits the operation of the kepboard. The numerical keys of the keyboard are locked until the SM key is depressed. Depressing the SM key with an input parameter selected on the input matrix causes the computer to perform a particular subroutine.

(2) *RECALL.* This key, when depressed, causes the value of the parameter selected by the input matrix to be displayed in the tube indicator display (Nixie readout). A parameter, previously entered in the machine memory, may be recalled by means of the Recall key.

(3) *LEFT, DOWN, DROP, —.* This key, when depressed, causes a negative sign to be associated with the numerical value entered by means of the numerical keys.

(4) *RIGHT, UP, ADD, +.* This key causes a positive sign to be associated with the numerical value entered by means of the numerical keys.

(5) *Keys 0–9, . (decimal point).* These keys are used to make a numerical entry including the decimal point. The keys are interlocked so two entries cannot be made by depressing two keys simultaneously. The numerical value is posted in the readout display as each numerical key is depressed. Each key must be released before a second key can be activated.

(6) *CLEAR.* This key, when depressed, erases an incorrect input from the readout display tubes and allows the operator to enter correct numerical data.

(7) *ENTER.* This key is depressed after the operator verifies the correctness of the input in the display tubes. The posted value is entered in computer memory and the displayed value disappears.

u. Input Selection Matrix. This input selection matrix consists of 64 windows with specifically prepared legends which represent a specific input function associated with a particular program stored in the computer memory. The desired input function is selected by depressing two buttons, one in the bottom row (1–8) and one in the left column (A–H). For a detailed discussion of the input selection matrix, see the appropriate manual of the FM 6–3–( )-series.

15. Operation Errors

The gun direction computer is capable of detecting operator errors in procedure. If the operator makes an error in procedure, an error indication is received from the computer. If the operator attempts to enter data by the keyboard without first depressing the SM key, the keyboard is locked. Information cannot be entered while the computer is performing computations, receiving or transmitting information. Indications of many operator errors are displayed in the NIXIE tubes. Typical operator error displays for cannon artillery applications and their meanings are listed as follows:

Display	*Meaning*
(1) NO SOLUTION—indicator lights flashing and gun orders displayed in NIXIE tubes.	Indicates a quadrant elevation too high for weapon.
(2) . . . 1—displayed in NIXIE tubes.	No battery button depressed.
(3) . . . . . 0—displayed in NIXIE tubes.	Target out of range, X charge used.
(4) . . . . . 8—displayed in NIXIE tubes.	Target at or before peak of trajectory; X charge.
(5) . . . . . 2—displayed in NIXIE tubes.	Fuze type and/or projectile type error; illegal combination of fuze and projectile type; no HOB entry when required; projectile weight too large.
(6) . . . . . 3—displayed in NIXIE tubes.	Observer corrections entered without an observer-target azimuth entry.

16. Operational Procedures

The computer is prepared for operation (par. 8) and preoperation tests are completed (pars. 10 and 11) to determine correct memory fill and proper functioning of the computer. For a detailed discussion of operational procedures see the appropriate manual of the FM 6–3–( )-series.

17. Operation Under Adverse Conditions

Special precautions must be exercised by the operator when operating the computer in extreme weather conditions, i.e., temperature, humidity, etc. TM 9–1220–221–10/1 discusses, in detail, the additional requirements.

CHAPTER 3

MAINTENANCE

Section I. PREVENTIVE MAINTENANCE

18. General

Preventive (1st echelon) maintenance must be performed at regular intervals by the operator to eliminate interference to the operational employment. The operator performs only that maintenance authorized by the maintenance allocation chart in TM 9–1220–221–20/1. Care must be exercised in handling to prevent unnecessary damage to the equipment.

19. Procedures

a. Inspection. The computer and its associated equipment should be inspected visually at frequent intervals. After transporting the computer from one position to another, it should be inspected for breaks, abrasions, or pin misalinement. Corrections or repairs should be made before operating the equipment.

b. Cleaning and Replacement. The operator is responsible for cleaning the computer to include all illuminating windows on the control panel. Lens paper or soft lint-free cloth should be used. One air filter located under the control panel assembly and one filter under the forward edge of the chassis assembly must be inspected and cleaned regularly. Wash the filters in soap or detergent and water. Dry with light air pressure only. Do not use high pressure air which might crush or bunch the filaments of the filter. Replace the cleaned air filters when dry. If the filters are crushed or otherwise damaged, the operator will replace them. Indicator lamps on the front panel of the computer are replaced by the operator when required.

20. Malfunction Indications

The operator should check the computer for malfunctions and for correct memory content by using the marginal test, which is a routine built into the computer. The test is performed by the operator when malfunction of the equipment is known or suspected. If the computer malfunction is verified by this test, the artillery communications specialist (radio mechanic) must be notified.

Section II. SECOND ECHELON MAINTENANCE

21. General

Second echelon maintenance is performed on the gun direction computer M18 by the radio mechanic (MOS 313.1) at all field artillery echelons.

22. Responsibilities

The responsibilities for second echelon maintenance are as follows:

a. Field Artillery Battalion. The battalion radio mechanics perform, on site, any item of second echelon maintenance that requires the use of the signal data reproducer AN/GSQ–64 (MLU), computer logic unit test set AN/GSM–70 (FALT), and the replacement of parts as prescribed by TM 9–1220–221–20/1. The battalion radio mechanics are trained to use the FALT and MLU equipment but they are limited in use because the equipment is not organic to the battalion. The battalion radio mechanic assists the radio mechanics of higher artillery echelons in diagnosing malfunctions and otherwise maintain computer equipment which is organic to the battalion.

b. Division Artillery, Field Artillery Group, and Corps Artillery. Radio maintenance personnel in the communication platoon of headquarters battery are responsible for performing second echelon maintenance on computer equipment issued to the headquarters battery

and to all attached or organic field artillery batteries and battalions. The signal data reproducer AN/GSQ–64 (MLU), computer logic unit test set AN/GSM–70 (FALT), and the authorized supply of spare parts are issued to headquarters battery of division artilleries, field artillery groups, and corps artilleries. The radio maintenance personnel of the headquarters battery are trained to use the above test equipment and to replace parts as prescribed by appropriate technical publications.

23. Test Equipment

a. The signal data reproducer AN/GSQ–64 (MLU) is used to fill the computer program into memory for specific artillery applications. It is used as an input device in conjunction with the computer logic unit test set AN/GSM–70 (FALT) to read the test tapes used to check the computer for malfunction. The radio mechanics in the headquarters and headquarters battery of division artillery, corps artillery and field artillery group are responsible for proper utilization of the MLU. The radio mechanics at battalion level are trained to use the MLU when required to fill the computer program into computer memory. A detailed description of the MLU is contained in TM 9–1220–221–20/1 and TM 9–1290–326–12.

b. The computer logic unit test set AN/GSM–70 (FALT) is used by the radio mechanics at division and crop artillery and field artillery group to test the logic of the gun direction computer and localize malfunctions to a specific logic circuit. The MLU is used to read the programed commands on the test tapes for functional testing of the computer. The radio mechanics perform the testing of all computers as indicated above. The detailed description of the FALT to include its operations, is contained in TM 9–1220–221–20/1 and TM 9–4931–204–12.

CHAPTER 4

DESTRUCTION OF EQUIPMENT

24. General

a. Tactical situations may arise in which it is necessary to abandon equipment in the combat zone. In such a situation all equipment to be abandoned must be destroyed to prevent its use by the enemy.

b. The destruction of equipment subject to capture or abandonment in the combat zone will be undertaken only upon authority delegated by a division or higher commander.

25. Principles

Plans will be prepared for destroying the computer and its auxiliary equipment in order to reduce the time required should destruction become necessary. The principles to be applied are as follows:

a. Plans for destruction of equipment must be adequate, uniform, and easily carried out in the field.

b. Destruction must be as complete as the available time, equipment and personnel will permit. Since complete destruction requires considerable time, *priorities* must be established so that the more essential parts are destroyed first.

c. The same essential parts must be destroyed on all like units to prevent the enemy from constructing a complete unit from damaged ones.

d. Spare parts and accessories must be given the same priorities as the parts installed on the equipment.

26. Methods

To destroy equipment adequately and uniformly, all personnel of the unit must know the plan and priority of destruction.

27. Destruction

For detailed information on destruction of the gun direction computer M18, see TM 9-1220-221-10/1.

APPENDIX

REFERENCES

1. Field Manuals

FM 5–25	Explosives and Demolitions.
FM 6–40	Field Artillery Cannon Gunnery.
FM 6–125	Qualification Tests for Specialists Field Artillery.

2. Technical Manuals

TM 5–6115–211–10	Operators Manual: Generator Set, Gasoline Engine: 3KW AC, 120 V, 1 and 3 Phase, 120/240 V, Single Phase, 120/208 V, 3 Phase, 400 Cycle Skid Mounted.
TM 5–6115–211–20	Organizational Maintenance: Generator Set, Gasoline Engine: 3KW AC, 120 V, 1 and 3 Phase, 120/240 V, Single Phase, 120/208 V, 3 Phase, 400 Cycle Skid Mounted.
TM 5–6115–211–20P	Organizational Maintenance Repair Parts and Special Tool List. Generator Set, Gasoline Engine: 3KW AC, 120 V, 1 and 3 Phase, 120/240 V, Single Phase, 120/208 V, 3 Phase, 400 Cycle Skid Mounted.
TM 9–1220–221–10/1	Operators Manual: Gun Direction Computer M18.
TM 9–1220–221–20/1	Organizational Maintenance: Gun Direction Computer M18.
TM 9–1220–221–20P	Organizational Maintenance Repair Parts and Special Tool List: Gun Direction Computer M18.

3. Miscellaneous

AR 611–201	Enlisted Military Occupational Specialties.
ATP 6–100	Army Training Program for Field Artillery Unit.
DA Pam 310-series	Index of Military Publications.

GLOSSARY

Address—An expression, usually numerical, which designates a particular location in a storage or memory device.

Arithmetic unit—That part of a computer which performs arithmetic operations.

Base—A number on which a mathematical system or calculation depends for example 10 is the base of the decimal system. The binary system has a base of 2.

Binary digit—A digit in the binary scale of notation.

Binary number—A number written in binary notation.

Binary number system—A scheme for representing numbers, characterized by the arrangement of numbers in sequence, in which the successive digits are interpreted as coefficients of the successive powers of the base 2, just as in the more familiar decimal number system they relate to successive powers of the base 10. Each *digit* of the number is a character which stands for zero or for a positive integer smaller than the base. Thus the only permissible digits in the binary system are 1 and 0. As an example:

101 in the binary system represents:
$1\times(2)^2+0\times(2)^1+1\times(2)^0=4+1=5$ in the decimal system.

101 in the decimal system represents:
$1\times(10)^2+0\times(10)^1+1\times(10)^0=101$.

Bit—(1) a binary digit.
—(2) A unit of storage capacity.

Coefficient—A number or symbol prefixed as a multiplier to a variable.

Computer—(1) A machine for performing calculations.
(2) A machine for transforming specified information.

Control element—Those parts of a digital computer which effect the carrying out of instructions in proper sequence, the interpretation of each instruction, and the application of the proper signals to the arithmetic unit or other parts in accordance with this interpretation.

Data—Facts, number, or quantities known or given in order to solve a problem or reach a conclusion.

Digit—One of the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9, used in numbering.

Digital computer—A computer which operates with information represented in digital form.

General purpose computer—Used to describe digital computers designated to perform a wide variety of tasks.

Integer—A whole number.

Input—Those components of a computer which serve to place information and instructions into the storage unit of the computer.

Instruction—A coded group of numbers or alphabetical characters and numbers, which directs the performance of a certain operation.

Language—A system consisting of—
(1) A well defined set of characters.
(2) Rules for combining characters with one another to form words or other expressions.
(3) A specific assignment of meaning to the words and expressions, usually for communication of information.

Machine language—A language occurring within a computer, ordinarily not perceptible or intelligible to persons without special equipment or training.

Memory—See storage.

Output—Those components of a computer which, upon a signal from the control unit, serve to obtain information from the computer.

Power—The product of the multiplication of a quantity by itself, as 32 is the fifth *power* of 2 (2^5).

Program—A set of coded instructions arranged in proper sequence to cause a computer to perform a desired operation, such as the solution of a mathematical problem.

Solid state—In electronics, a term referring to those circuits which contain no vacuum tubes.

Storage—That section of a computer which retains and stores instructions and information. The terms storage and memory are used interchangeably.

Word—An ordered set of characters which is the normal unit in which information may be stored, transmitted, or operated upon within a computer.

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Ft Hood (2)
Ft Lewis (2)
Ft Riley (2)
Ft Benning (2)
Units org under fol TOE:
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6-125 (5)
6-135 (5)
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6-315 (5)
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6-330 (2)
6-405 (5)
6-415 (5)
6-417 (2)
6-418 (2)
6-425 (5)
6-435 (5)
6-525 (5)
6-565 (5)

NG: State AG (3); units—same as active Army except allowance is two (2) copies to each unit.

USAR: Same as active Army except allowance is one copy to each unit.

For explanation of abbreviations used, see AR 320-50.

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